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(54) **APPARATUS AND METHOD FOR COATING AND INSPECTING OBJECTS**

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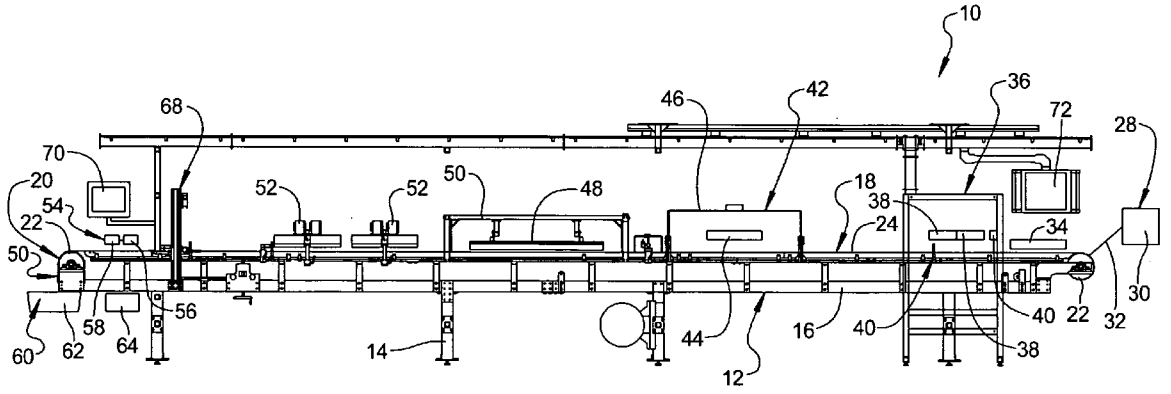
(57) **ABSTRACT**

An apparatus and method for inspecting objects for an inspection criteria thereon includes a conveyor to receive a plurality of objects, a removal assembly located along the conveyor for removing the objects, and an inspection system located along the conveyor prior to the removal assembly for inspecting the objects against a predetermined inspection criteria to determine to reject or pass the inspected objects and to actuate the removal assembly to remove the inspected objects from the conveyor that are passed and to leave the inspected objects that are rejected on the conveyor to subsequently exit the conveyor.



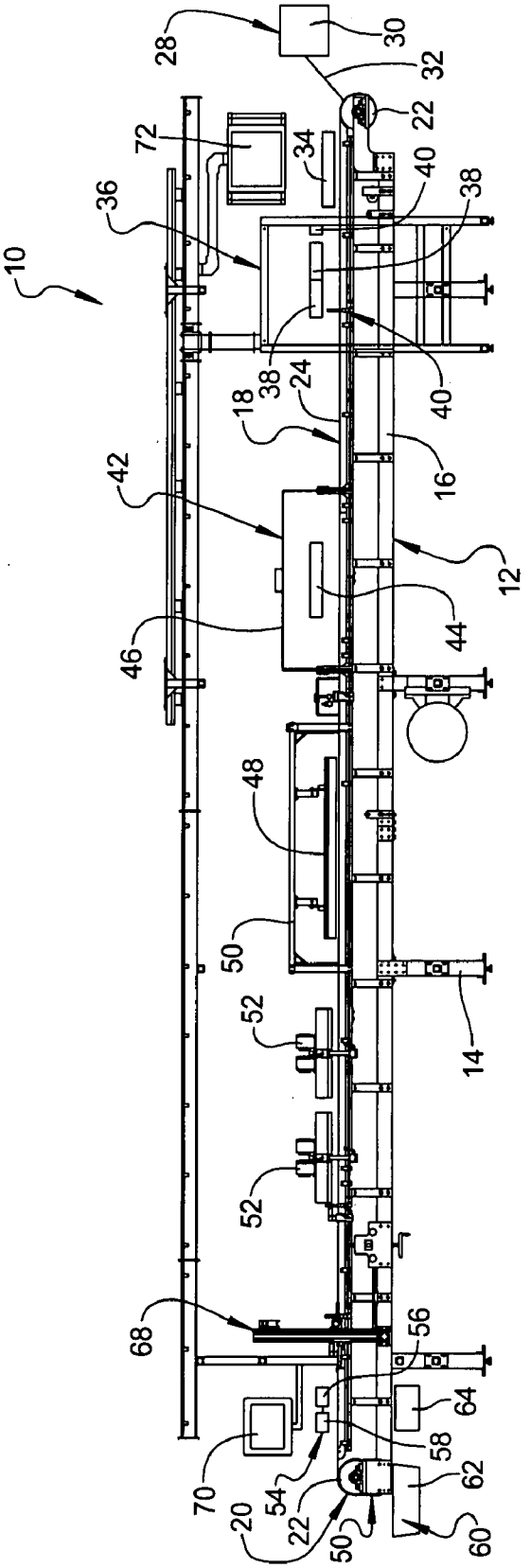

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FIG 1

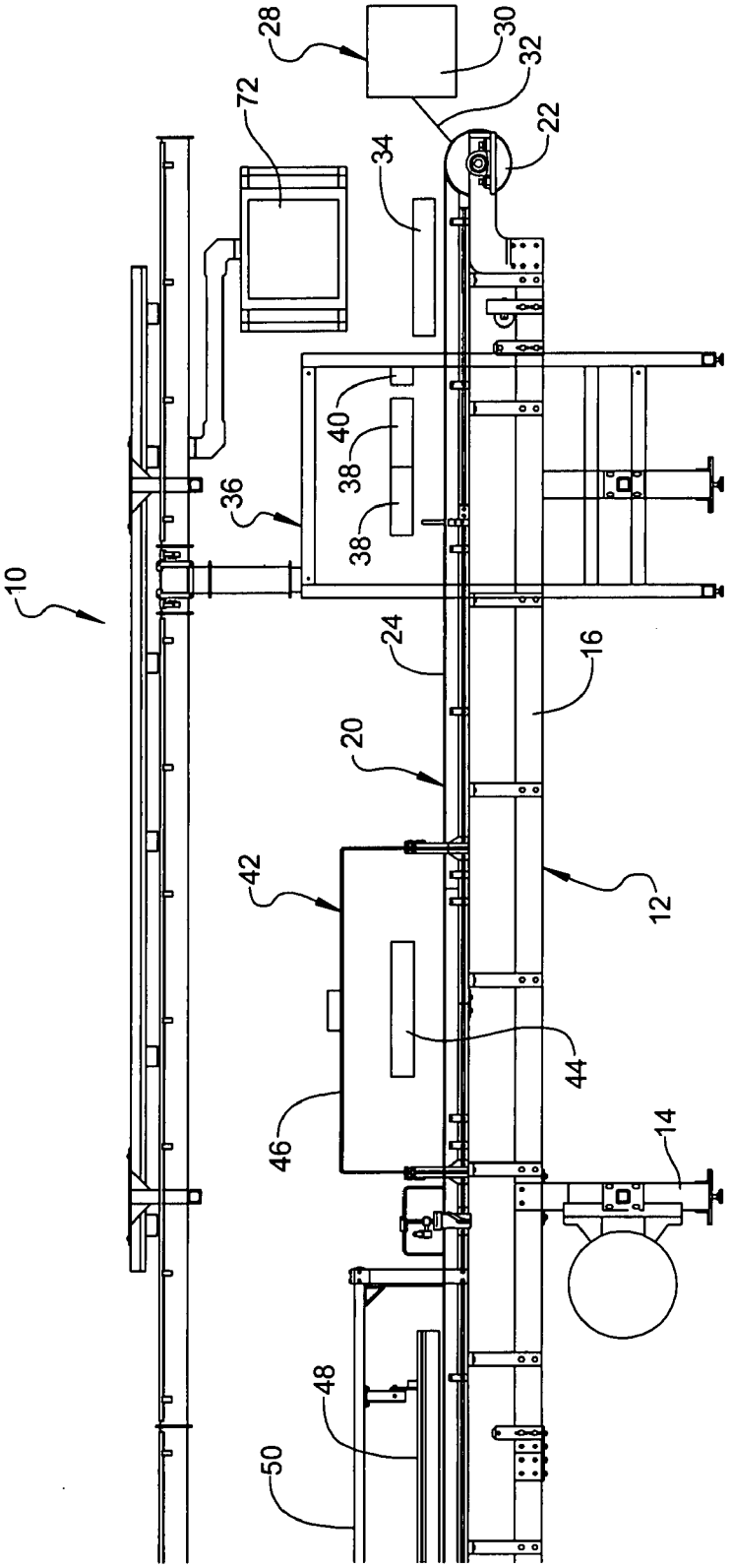


FIG 1A

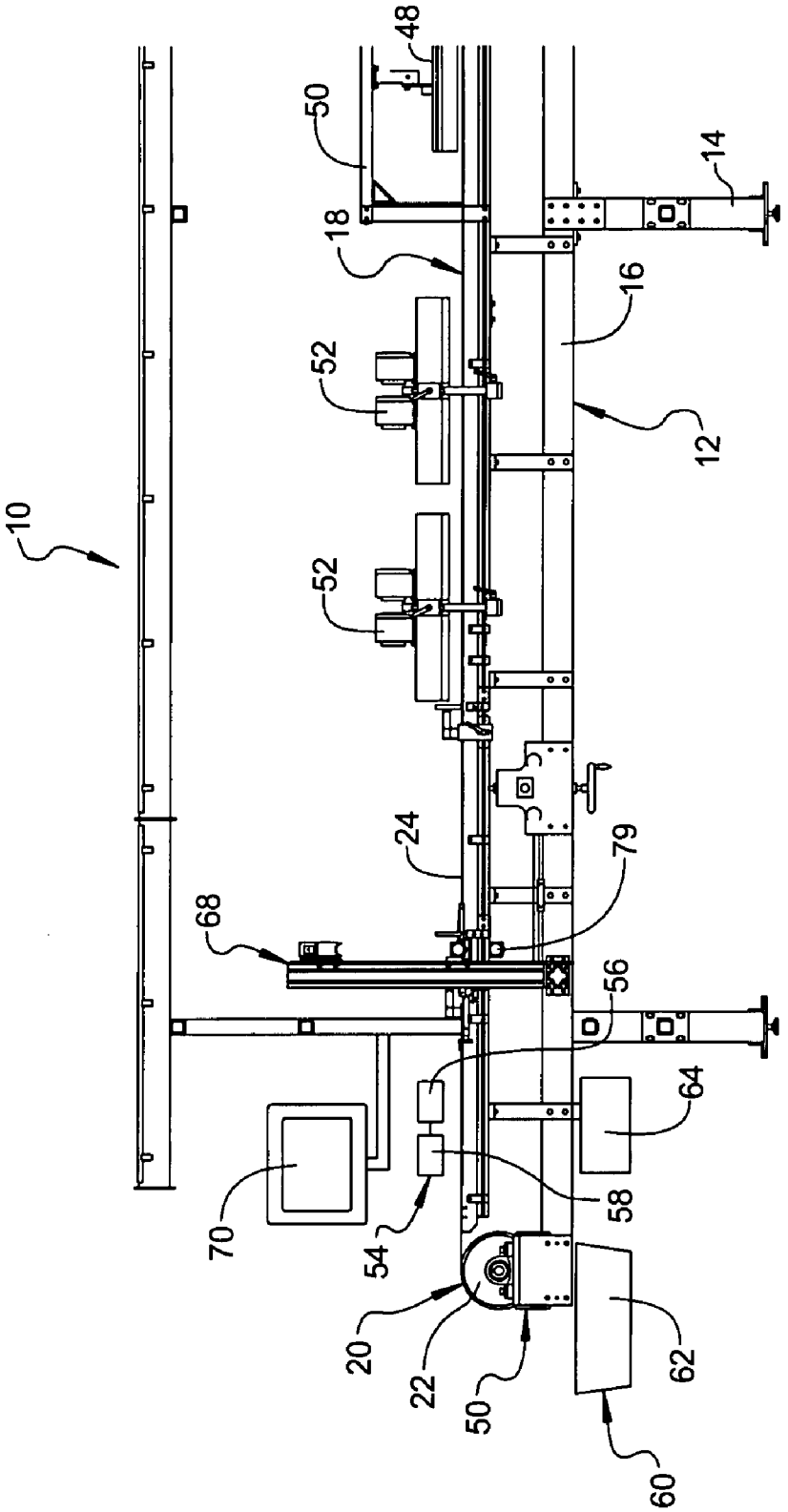


FIG 1B

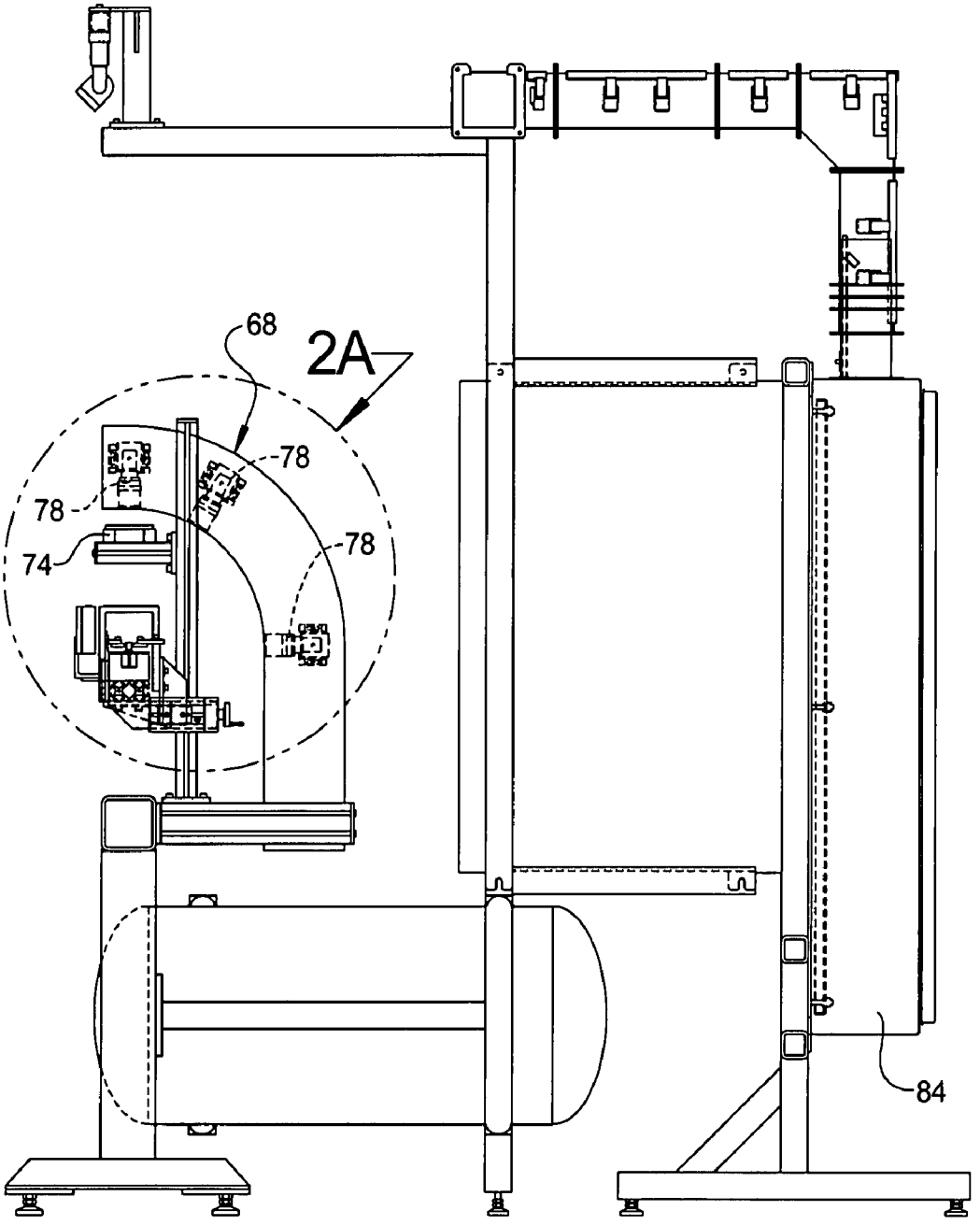


FIG 2

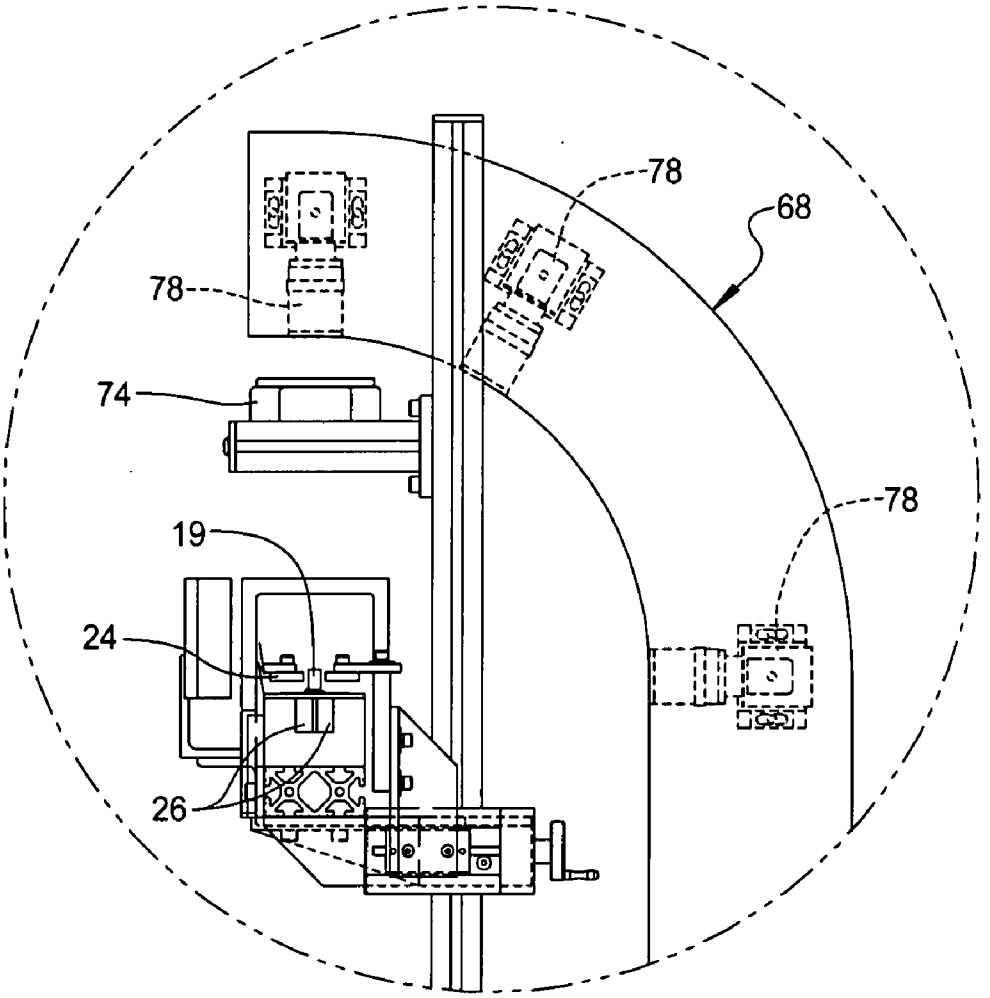
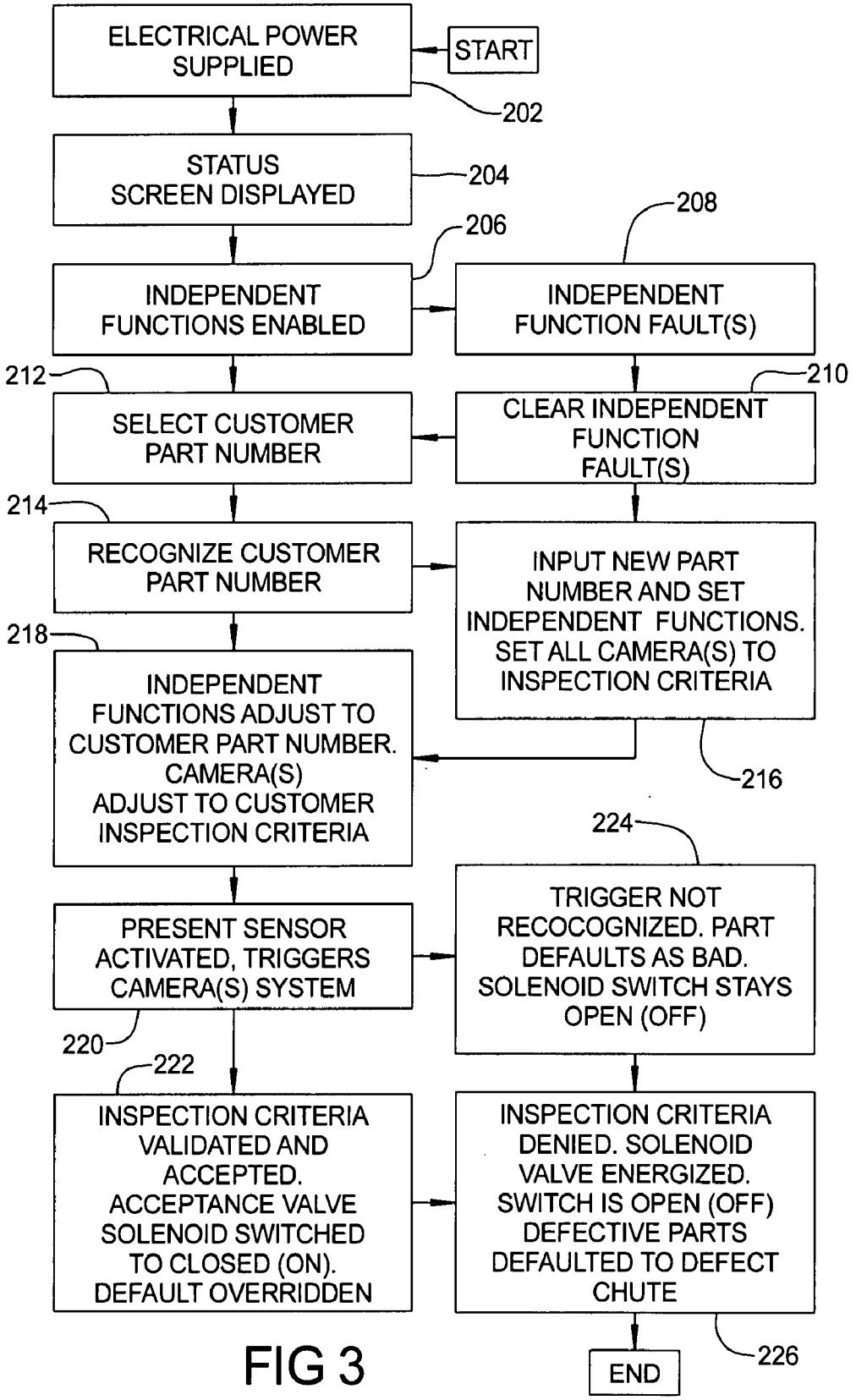


FIG 2A


ELECTRICAL POWER SUPPLIED
START
202
STATUS SCREEN DISPLAYED
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206
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INDEPENDENT FUNCTIONS ENABLED
INDEPENDENT FUNCTION FAULT(S)
212
210
SELECT CUSTOMER PART NUMBER
CLEAR INDEPENDENT FUNCTION FAULT(S)
214
RECOGNIZE CUSTOMER PART NUMBER
INPUT NEW PART NUMBER AND SET INDEPENDENT FUNCTIONS. SET ALL CAMERA(S) TO INSPECTION CRITERIA
218
216
INDEPENDENT FUNCTIONS ADJUST TO CUSTOMER PART NUMBER. CAMERA(S) ADJUST TO CUSTOMER INSPECTION CRITERIA
224
PRESENT SENSOR ACTIVATED, TRIGGERS CAMERA(S) SYSTEM
TRIGGER NOT RECOCOGNIZED. PART DEFAULTS AS BAD. SOLENOID SWITCH STAYS OPEN (OFF)
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INSPECTION CRITERIA VALIDATED AND ACCEPTED. ACCEPTANCE VALVE SOLENOID SWITCHED TO CLOSED (ON). DEFAULT OVERRIDDEN
INSPECTION CRITERIA DENIED. SOLENOID VALVE ENERGIZED. SWITCH IS OPEN (OFF) DEFECTIVE PARTS DEFAULTED TO DEFECT CHUTE
226
END

FIG 3

APPARATUS AND METHOD FOR COATING AND INSPECTING OBJECTS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates generally to inspection of objects and, more specifically, to an apparatus and method for coating and inspecting an inspection criteria on objects such as fasteners.

[0003] 2. Description of the Related Art

[0004] It is known to apply a coating to objects such as fasteners with automated machinery. Once the coating is applied, the fasteners are inspected to determine if the coating or an additional attribute(s) such as thread pitch, thread diameter, thread length, fastener head style, or head marking of the fastener was sufficient to meet predetermined inspection criteria. For example, the fasteners are inspected to determine if the coating covers a predetermined area of the fasteners. This inspection of the coated fasteners is needed for processing quality control.

[0005] One method of inspecting the fasteners is to manually and visually inspect the fasteners. This may be performed randomly or in entirety. However, this inspection method is laborious and time consuming. Manual inspection requires the presence of an operator, limits processing speed, and is also dependent on variable parameters such as operator fatigue.

[0006] Another method of inspecting the fasteners is to use a machine vision system for automatically and continuously monitoring and controlling the processing of fasteners. An example of such a method is disclosed in U.S. Pat. No. 6,620,246 to Alaimo et al. In this patent, a process controller enables automatic and sequential start-up and shut-down of one or more fastener coating machines and/or subsystems for each machine. The process controller includes a fiber optic light source, a programmable logic controller, and a camera controller. A dial machine for coating internally threaded fasteners includes various ejector tubes for accommodating fasteners and may include a "purge" ejector tube for conveying fasteners or parts to a recycling location, a "defective parts" ejector tube for conveying fasteners to a defective parts bin, and a "good parts" ejector tube for conveying properly coated fasteners to a cooling location. Fasteners may be selectively ejected from a turntable track using bursts of compressed air from tubes. A camera housing is provided for conveying video images to the process controller. A suitable machine vision system may be used with the process controller.

[0007] Therefore, it is desirable to provide an apparatus to coat objects and then to inspect objects such as fasteners for process quality control. It is also desirable to provide an apparatus to automatically inspect coated fasteners after the coating process and additional attributes of the fasteners. It is further desirable to provide an apparatus and methodology in which passed objects from inspection flow to a good part removal and are removed and rejected objects from inspection flow to a default part removal and removed. Thus, there is a need in the art to provide an apparatus and methodology that meets at least one of these desires.

SUMMARY OF THE INVENTION

[0008] It is, therefore, one object of the present invention to provide an apparatus and method for inspecting objects for process quality control.

[0009] It is another object of the present invention to provide an apparatus and method that automatically inspects objects.

[0010] It is yet another object of the present invention to provide an apparatus and method to coat fasteners and inspect coated fasteners and additional attributes of the fasteners.

[0011] To achieve one or more of the foregoing objects, the present invention is an apparatus for inspecting objects for an inspection criteria thereon. The apparatus includes a conveyor to receive a plurality of objects and a removal assembly located along the conveyor for removing the objects. The apparatus also includes an inspection system located along the conveyor prior to the removal assembly for inspecting the objects against a predetermined inspection criteria to determine to reject or pass the inspected objects and to actuate the removal assembly to remove the inspected objects from the conveyor that are passed and to leave the inspected objects that are rejected on the conveyor to subsequently exit the conveyor.

[0012] Also, the present invention is a method for coating and inspecting objects for an inspection criteria thereon. The method includes the steps of providing a conveyor, receiving a plurality of objects on the conveyor, and conveying the objects along the conveyor. The method also includes the steps of inspecting the objects with an inspection system located along the conveyor against a predetermined inspection criteria, determining to reject or pass the inspected objects, removing the passed objects from the conveyor with a removal assembly by actuating the removal assembly if the inspected objects are passed, and leaving the rejected objects on the conveyor if the inspected objects are rejected to subsequently exit the conveyor.

[0013] One advantage of the present invention is that an apparatus and method is provided for inspecting a flow of objects such as fasteners in an ordinate and incremental position at a high rate of speed. Another advantage of the present invention is that the an inspection methodology is provided in which passed objects from inspection flow to a good object removal and are removed and rejected objects from inspection flow to a default object removal and are removed.

[0014] Yet another advantage of the present invention is that the apparatus and method automatically inspects coated objects such as fasteners and additional attributes of the fasteners after the coating process.

[0015] Other objects, features, and advantages of the present invention will be readily appreciated, as the same becomes better understood, after reading the subsequent description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. **1** is a front elevational view of an apparatus, according to the present invention.

[0017] FIGS. **1**A and **1**B are enlarged views of the apparatus of FIG. **1**

[0018] FIG. **2** is a side elevational view of the apparatus of FIG. **1**.

[0019] FIG. **2**A is an enlarged elevational view of a portion of the apparatus in circle **2**A of FIG. **2**.

[0020] FIG. **3** is a flowchart of a method, according to the present invention, of inspecting objects using the apparatus of FIG. **1**.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0021] Referring now to the drawings, and in particular FIGS. **1**, **1**A, and **1**B, one embodiment of an apparatus **10**, according to the present invention, is shown. The apparatus **10** includes a support frame, generally indicated at **12**. The support frame **12** includes at least one, preferably a plurality of columns **14** and at least one, preferably a plurality of beams **16** connected together by a suitable mechanism such as brackets and fasteners.

[0022] The apparatus **10** also includes a conveyor system, generally indicated at **18**, for conveying objects such as fasteners **19** (FIG. **2**A). The objects such as fasteners **19** each have a diameter of approximately 0.020 inches to approximately 2.0 inches and a length of approximately 0.030 inches to approximately 5.00 inches. It should be appreciated that the objects may be of a type other than fasteners.

[0023] The conveyor system **18** is of a magnetic and linear flow type. The conveyor system **18** includes a drive system, generally indicated at **20**, for moving a belt **24** to be described. In one embodiment, the drive system **20** includes a plurality of rotatable wheels **22** rotatably supported on the support frame **12**. The wheels **22** are rotatably connected to the support frame **12** by a suitable mechanism such as brackets and fasteners. Two of the wheels **22** are spaced longitudinally from each other with one wheel **22** located at one longitudinal end of the support frame **12** and the other wheel **22** located at the other end of the support frame **12** for a function to be described. The drive system **20** also includes a motor (not shown) connected to a rotatable shaft (not shown) on which one of the wheels **22** are rotatably mounted via a transmission (not shown). The motor is of a variable speed type and allows the speed of the belt **24** to be selectively adjusted to a desired consistent speed. Depending upon the type of fasteners processed, the practical belt speed typically ranges from about 30 to about 60 feet/minute, thereby enabling production of 10,000 to more than 160,000 parts/hour by the present invention, depending upon the part, its shape, and size. It should be appreciated that the motor is electrically connected to a source of power such as an apparatus controller **84** to be described.

[0024] Referring to FIGS. **1** through **2**A, the conveyor system **18** includes at least one belt **24** disposed about the wheels **22**. The belt **24** is disposed about two longitudinally spaced wheels **22**. The conveyor system **18** includes at least one, preferably a pair of magnets **26** disposed below the belt **24**. The magnets **26** extend longitudinally and are spaced laterally. The magnets **26** are operatively connected to the support frame **12** by a suitable mechanism such as brackets and fasteners. The fasteners **19** are magnetically held on the belt **24** via the magnetic field generated by the magnets **26** through the belt **24** for moving the fasteners **19**. It should be appreciated that the wheels **22** and belt **24** can be readily adjusted on the conveyor system **18** to accommodate different types and sizes of objects such as fasteners. It should be appreciated that the belt **24** is closed to form a closed-loop.

[0025] The apparatus **10** also includes a feeder system, generally indicated at **28**, positioned at one end of the conveyor system **18** to feed the fasteners **19** to the conveyor system **18**. The fasteners **19** are orientated and aligned in a uniform manner by the feeder system **28**. The feeder system **28** includes a vibratory feed bowl mechanism **30**. The feeder system **28** also includes a gravity down track or vibratory in-line track mechanism **32** cooperating with the vibratory feed bowl mechanism **30** and the conveyor system **18**. The track mechanism **32** is adjustable from zero degrees (0°) to thirty-five degree (35°) and positioned in a downward slope gravity or vibratory in-line linear type. The track mechanism **32** conveys the fasteners **19** from the vibratory feed bowl mechanism **30** and delivers the fasteners **19** to the conveyor system **18**. The feeder system **28** may include a metering wheel or feed wheel mechanism (not shown) to meter the fasteners **19** from the track mechanism **32** to engagement with the conveyor system **18**. The feed wheel mechanism moves the fasteners **19** and holds the fasteners **19** generally perpendicular to the surface of the belt **24** of the conveyor system **18**. In another embodiment, the fasteners **19** could be fed by hand to the conveyor system **18**. It should be appreciated that the feed wheel mechanism has independent vertical and horizontal adjustment. It should also be appreciated that a motor (not shown) for the feed wheel mechanism can be adjusted for relatively slow or fast speeds. It should further be appreciated that the feeder system **28** can take many different forms that are well known in the art.

[0026] Referring to FIGS. **1** through **2**A, the apparatus **10** also includes a heating device **34** positioned after the feeder system **28** along the conveyor system **18**. The heating device **34** is of a forced air type. The heating device **34** includes a blower (not shown) mounted to the support frame **12** by a suitable mechanism such as brackets and fasteners. The blower intakes air, heats the air, and discharges the heated air. The heating device **34** may include a manifold (not shown) connected to the blower to receive and distribute the heated air to allow the heated air to be directed toward the fasteners **19**. The heating device **34** pre-heats the objects such as the fasteners **19** to about 100° F. to about 450° F. prior to the application of any liquid coating materials. It should be appreciated that, in certain limited instances, such pre-heating of the fasteners **19** may assist in the distribution of liquid coating material applied to the fasteners **19**.

[0027] The apparatus **10** includes a liquid applicator system, generally indicated at **36**, located along the conveyor system **18**, after the heating device **34**, to apply a liquid coating to the fasteners **19**. The liquid applicator system **36** includes at least one, preferably a plurality of applicators **38** for applying a liquid coating to the objects such as the fasteners **19**. The applicators **38** are two dispensing modules on opposed sides of the fasteners **19** that release a preset or predetermined amount of material to a precise location. In one embodiment, the precise location is the flanged portion of the fastener **19**. The applicators **38** used in connection with the present invention preferably utilize a nozzle diameter and range from about 0.005" to about 0.120" and are supplied with coating material under pressure of about 30 PSI. Preferably, the applicators **38** are Nordson® gun modules of approximately 0.032 in size. Although a variety of different dispensing applicators can be utilized for the purpose of metering precise high speed discrete shots of liquid material, a particularly preferred gun has been found to be a Nordson® Zero Cavity Module with a Number 276515 module manufactured by the Nordson Corporation of Norcross, Ga. Again, although a variety of different stages can be used, a particularly preferred stage has been found to be the 4500 Series ballbearing stage manufactured by the Daedal Division of the Parker Corporation of Harrison City, Pa. It should be appreciated that the applicators **38** apply liquid coating materials to objects such as fasteners that may have odd shapes, flanged heads, deep threads, extended threaded portions, off center

openings, or are otherwise particularly difficult to completely or partially coat. It should also be appreciated that it is possible to use a single applicator **38** and a single shot of discrete material in connection with the present invention or any number of additional applicators **38** to deliver multiple discrete shots of material onto the fasteners **19**. It is preferred that the applicators **38** be fully capable of applying at least 20,000 and preferably up to 150,000 discrete shots of material per hour.

[0028] The applicators **38** are supplied with liquid coating material from an off-line supply container (not shown). In one embodiment, the liquid coating material is a plastisol that is commercially available from ND Industries, Inc., of Clawson, Mich. It should be appreciated that the applicators **38** are capable of delivering high-speed accurate metered shots of a wide variety of liquid coating materials. It should also be appreciated that, in other embodiments, the liquid coating materials may include, but are not limited to, fluorocarbons, hydrocarbon and fluorocarbon copolymers, silicones, waxes, petroleum greases, Teflon™, sealant materials, Hot Melt Adhesives, PUR's, and EEAs (ethylene/acrylic copolymer (s)). It should further be appreciated that the applicators **38** may be mounted on adjustable support mounts (not shown) on the support frame **12** to position the applicators **38** in three dimensions, e.g., longitudinally, laterally, and vertically, relative to the fasteners **19**. It should be appreciated that the adjustment devices are manually operated.

[0029] The apparatus **10** includes at least one sensor **40** mounted in close proximity to the applicators **38**. The sensor (s) **40** is of an optical type. When the sensor(s) **40** senses a predetermined portion of the fastener **19**, it triggers a discrete shot of the liquid coating material to be precisely delivered onto the predetermined location of the detected fastener **19**. A particularly preferred sensor for this purpose has been found to be the model FX7 manufactured by Sunx Sensors Corporation. An alternative preferred sensor has been found to be the Model No. PZ-101 manufactured by Keyance Corporation. It should be appreciated that the location, speed, and amount of material that is deposited are controllable by the applicators **38** acting in combination with the sensor **40**. It should also be appreciated that the sensor **40** is conventional and known in the art.

[0030] Referring to FIGS. **1** through **2**A, the apparatus **10** includes a curing device, generally indicated at **42**, located along the conveyor **18**, after the liquid applicator system **36**, to cure the liquid coating material on the fasteners **19**. The curing device **42** includes at least one heater **44** to heat the fasteners **19** after the application of the liquid coating material. The heater **44** is of an induction coil type. The heater **44** heats the fasteners **19** such that the coating material on the fasteners **19** cures from the inside to bond the liquid coating material to the fasteners **19**. The curing device **42** may include a shield **46** disposed above the heater **44** and connected to the frame **12**. It should be appreciated that, after the application of liquid coating material is deposited on the fasteners **19**, the heater **44** raises the temperature of the fasteners **19** to an elevated temperature such as 350° F. It should also be appreciated that the heater **44** is conventional and known in the art.

[0031] The curing device **42** also includes least one, preferably a plurality of lamps **48**. The lamps **48** are of a Quartz type that can be varied in temperature and intensity. The lamps **48** cure the outside of the coating material on the fasteners **19**. The lamps **48** are supported above the belt **24** by a support structure **50** made from brackets and fasteners connected to the support frame **12**. It should be appreciated that, after exiting the heater **44**, the heated fasteners **19** are subjected to a final post cure process by the lamps **48**.

[0032] Referring to FIGS. **1** through **2**A, the apparatus **10** also includes at least one, preferably a plurality of cooling devices **52** positioned along the conveyor system **18** after the final post curing. Each cooling device **52** is of a forced air type. The cooling device **52** includes a blower (not shown) mounted to the frame **12** by a suitable mechanism such as brackets and fasteners. The blower intakes air and discharges high velocity ambient air. The cooling device **52** also includes a manifold (not shown) connected to the blower to receive and distribute the cooled air to allow the cooled air to be directed toward the fasteners **19**. The cooling device **52** cools the fasteners **19** to about 100° F. to about 150° F. prior to inspection.

[0033] The apparatus **10** also includes a removal assembly, generally indicated at **54**, located at the end of the conveyor system **18**. The removal assembly **54** includes a purge tube **56** connected to the support frame **12** by suitable means such as brackets and fasteners. The removal assembly **54** also includes an actuator **58** such as a solenoid-actuated valve connected to the purge tube **56** to allow pressurized air from an air source (not shown) to flow through the purge tube **56**. The actuator **58** is also connected to the apparatus controller **84** to be described. The purge tube **56** is oriented to deliver pressurized air laterally across the surface of the belt **24** to remove fasteners **19** from the conveyor system **18**.

[0034] The apparatus **10** includes a collector system, generally indicated at **60**, disposed below the belt **24** at the end of the conveyor system **18**. The collector system **60** includes a first collector **62** for objects such as fasteners **19** that have failed inspection. The first collector **62** may be supported by a cart (not shown) or the support frame **12**. The first collector **62** may be a bucket and/or removable from the cart or support frame **12**. The collector system **60** also includes a second collector **64** for objects such as fasteners **19** that have passed inspection. In one embodiment, the second collector **64** is a conveyor disposed below and generally perpendicular to the conveyor system **18**.

[0035] The apparatus **10** also includes an inspection system, generally indicated at **68**, for inspecting the objects such as fasteners **19** to reject or pass the fasteners **19** based on a predetermined criteria such as a coating thereon or other attributes of the fasteners **19**. The inspection system **68** cooperates with the apparatus controller **84** to be described for controlling the inspection process. The inspection system **68** includes a camera controller or processor **70** having a microprocessor, memory, and input/output. The camera controller **70** may have a display for images and may permit manual operator setup, programming, and evaluation of the inspected criteria. The inspection system **68** also includes an interactive or human machine interface **72** such as an operator touch screen electrically connected to the camera controller **70**. It should be appreciated that the camera controller **70** may be a separate controller or integrated into one controller with the apparatus controller **84**. It should also be appreciated that the camera controller **70** may accommodate color or gray scale data acquisition. It should further be appreciated that encoders (not shown) may be provided to cooperate with the inspection system **68** to track objects such as the fasteners **19** prior to and/or after the inspection system **68** along the conveyor system **18**.

[0036] The inspection system **68** further includes at least one, preferably a plurality of light sources **74**. The light

sources **74** illuminate the objects such as the fasteners **19** for the inspection system **68**. The light sources **74** may be of any suitable type such as light emitting diode (LED) or fluorescent. It should be appreciated that the light sources **74** maintain a constant light emitting power and bath the fasteners **19** with light to reduce the affect of variations in ambient lighting during the inspection process.

[0037] The inspection system **68** further includes at least one inspection camera **78** or camera system for inspecting objects or parts such as the fasteners **19**. Preferably, the inspection system **68** includes a plurality of cameras **78** or camera systems that may be designated as primary and secondary inspection cameras depending on the criteria to be inspected. As illustrated, two of the inspection cameras **78** are disposed above the belt **24** and one inspection camera **78** is disposed on the side of the belt **24** and are supported by the support frame **12** by a suitable mechanism such as brackets and fasteners. The inspection cameras **78** are electrically connected to the camera controller **70** previously described. Each inspection camera **78** takes a digital image of each object such as a fastener **19** and is sent to the camera controller **70**. It should be appreciated that the camera controller **70** receives the image from each inspection camera **78** and determines whether each object such as the fastener **19** passes or fails a predetermined criteria and signals the apparatus controller **84**. It should also be appreciated that a presence sensor **79** (FIG. **1**B) such as a fiber optic through beam sensor or a laser sensor located on the apparatus **10** may be used as a camera trigger with the camera controller **70** and inspection cameras **78**. It should further be appreciated that the inspections cameras **78** are conventional and known in the art. It should still further be appreciated that the apparatus controller **84** controls actuation of the actuator **58** via a signal from the camera controller **70**.

[0038] The apparatus **10** includes an apparatus controller **84** for controlling the overall operation of the apparatus **10**. The apparatus controller **84** includes a microprocessor, memory, and input/output. The apparatus controller **84** may have a display for images and may permit manual operator setup, programming, and evaluation of the apparatus **10**. The apparatus controller **84** is connected to one or more components and/or subsystems of the apparatus **10**. The apparatus controller **84** enables the automatic and sequential start-up and shut-down of one or more apparatuses **10** and/or subsystems for such apparatuses **10**. It should be appreciated that the apparatus controller **84** for the apparatus **10** is of a programmable logic controller type. It should also be appreciated that the apparatus controller **84** is connected to other components of the apparatus **10** including those not shown or described.

[0039] In one embodiment of operation of the apparatus **10**, objects or parts such as the fasteners **19** are loaded into the feeder **30**. The fasteners **19** are fed from the feeder **30** to the track mechanism **32** and feed wheel mechanism and onto the belt **24**. The magnetic belt **24** holds each fastener **19** in a vertical fashion with the shaft thereof facing upwardly above the belt **24**. The drive system **20** moves the belt **24** longitudinally, thereby moving the fasteners **19** toward the removal assembly **54**. It should be appreciated that the fasteners **19** are held by the belt **24** due to the magnetic attraction of the magnets **26** and moved therealong.

[0040] The fasteners **19** move pass the heating device **34** and are heated by the heated air from the blower. The fasteners **19** are moved by the belt **24** over the wheels **22** and are presented with the heads **14** facing downwardly. The fasteners **19** are sensed by the sensor(s) **40** and the applicators **38** are activated to release a predetermined amount of liquid coating material to a precise location to the flanged portion of the fastener **19**. It should be appreciated that the fasteners **19** are moved by the belt **24** toward the curing device **42**.

[0041] The fasteners **12** pass by the heater **44** and the heater **44** heats the fasteners **19** to an elevated temperature to bond and partially cure the inside of the coating material to the fasteners **19**. After the heater **44**, the fasteners **19** pass by the lamps **48** and the lamps **48** cure the outside of the coating material. After the curing device **42**, the fasteners **19** move pass the cooling devices **52** and are cooled by the high velocity air from the blowers.

[0042] After cooling the coating on the fasteners **19**, the fasteners **19** pass at least one presence sensor mounted to the support frame **12** in close proximity to the inspection system **68**. When the sensor senses the fastener **19**, it sends a signal to the camera controller **70** to indicate that a fastener **19** is present. The encoder is then activated by the apparatus controller **84** to track the fastener **19** along the conveyor system **18**. It should be appreciated that the sensor and encoder are conventional and known in the art.

[0043] After the presence sensor, the fasteners **19** pass by at least one inspection camera **78** and the inspection camera **78** takes a digital image of each fastener **19** and is sent to the camera controller **70**. In the embodiment illustrated, three inspection cameras **78** take a digital image of the fastener **19** as it travels in front of the cameras **78**. The camera controller **70** compares the digital image to one stored in memory to determine whether the fastener **19** passes or fails at least one predetermined inspection criteria, for example, whether coating material is present on the fastener **19**, whether the coating material covers a predetermined portion of the fastener **19**, whether dimensional criteria of the fastener **19** has been met, etc.

[0044] If the camera controller **70** determines that the fastener **19** has failed or not passed the inspection criteria, the fasteners **19** exit the belt **24**. The fastener **19** will fall off the end of the belt **24** due to the loss of magnetic attraction and fall into the first collector **62**. This is the default position. If the camera controller **70** determines that the fastener **19** has passed the inspection criteria, the camera controller **70** will send a signal to the apparatus controller **84**, which in turn sends a signal to the actuator **58**, to allow air to the purge tube **56** to blow the fastener **19** off the belt **24** laterally to the second collector **64**. This is the passed position. It should be appreciated that the default position is the failed position.

[0045] Referring to FIG. **3**, a method of inspecting objects or parts such as fasteners with the apparatus **10** is shown. The methodology starts and advances to block **202**. In block **202**, the methodology includes the step of supplying electrical power to the apparatus **10**. Power from a power source (not shown) is supplied to the apparatus controller **84**, camera controller **70**, human machine interface **72**, and inspection cameras **78**. It should be appreciated that power is also supplied to other components of the apparatus **10** not shown or described.

[0046] After block **202**, the methodology advance to block **204** and displays the apparatus status screen on the interface **72**. The apparatus status screen displays information such as machine status, individual device status, air pressure, belt speed, and induction heater settings. The methodology then advances to block **206** and enables independent functions of

the apparatus **10** such as proper belt speed, proper induction heater settings, and proper air pressure. The apparatus controller **84** and interface **72** enable the independent functions of the apparatus **10** by validation of preset variables for processing belt speed, air pressure, and induction heater settings. From block **206**, the methodology may advance to either block **208** or **212**. In block **208**, the methodology checks for independent function faults of the apparatus **10**. The apparatus controller **84** and interface **72** check for independent function faults, such as improper air pressure, of the apparatus **10** by monitoring preset variables required for processing. The methodology then advances to block **210** and clears independent function faults of the apparatus **10**. The apparatus controller **84** and interface **72** clear the independent function faults of the apparatus **10** by enabling and validating preset variables inputted by the operator of the apparatus **10**.

[0047] From either block **206** or **210**, the methodology advances to block **212** and selects a customer part number. The operator inputs a customer part number into the apparatus controller **84** via the interface **72** by selecting a customer part number from a predetermined list of customer part numbers. From block **212**, the methodology advances to block **214** and the functions of the apparatus **10** recognize the customer part number. The apparatus controller **84** recognizes the customer part number and operates the apparatus **10** according to the functions associated with the customer part number. The methodology then advances to either blocks **216** or **218**.

[0048] In block **216**, the methodology inputs a new customer part number and sets independent functions of the apparatus **10** if no customer part number is selected from the predetermined list of customer part numbers. The operator inputs a new customer part number into the apparatus controller **84** via the interface **72** and camera controller **70** and sets independent functions of the apparatus **10** such as coating area, fastener length, thread pitch, and other inspection attributes defined by the customer into the apparatus controller **84** via the interface **72** such that the functions are related or associated with the new customer part number. The methodology also sets all camera systems to the customer's inspection criteria. The operator sets the camera systems to the customer's inspection criteria with the camera controller **70** by selecting from a predetermined list of inspection criteria such as previously described. From block **214** or block **216**, the methodology advances to block **218**.

[0049] In block **218**, the methodology adjusts independent functions of the apparatus **10** to the customer part number. The apparatus controller **84** adjusts independent functions of the apparatus **10** such as air pressure, induction heater settings, belt speed, and inspection criteria related to the customer part number. The methodology also adjusts the camera systems to the customer inspection criteria. The camera controller **70** adjusts the camera systems to the customer inspection criteria by recognizing good or acceptable inspection criteria for acceptance and recognizing bad or unacceptable inspection criteria for rejection. The methodology advances to block **220** and activates a part or object presence sensor and triggers one or more inspection camera **78** for an inspection criteria such as a material detection of the coating on the fastener **19**. The presence sensor is activated and sends a signal to the camera controller **70** and a signal to the inspection cameras **78**. The methodology also sets an encoder to tract the object or part. The camera controller **70** sends a signal to the encoder to track the fastener **19** along the belt **24**. After block **220**, the methodology advances to either block **222** or **224** to be described.

[0050] In block **222**, the methodology validates and accepts the inspection criteria. The inspection camera **78** sends a digital image of the fastener **19** passing thereby to the camera controller **70**. The camera controller **70** compares the digital image to data stored in memory to validate the inspection criteria for the fastener **19**. If the inspection criteria is valid, the camera controller **70** accepts the inspection criteria. The methodology activates the actuator **58** and the default is overridden. The controller closes or switches on the acceptance valve solenoid on the actuator **58** to allow air to the purge tube **56** to purge the fastener **19** from the belt **24** to the second collector **64**. The methodology advances to block **226** to be described.

[0051] In block **224**, the methodology denies the inspection criteria and the encoder continues to track the fastener **19**. The camera controller **70** compares the digital image to data stored in memory to validate the inspection criteria of the fastener **19**. If the inspection criteria is not valid, the camera controller **70** rejects the object to be inspected. The controller maintains the solenoid switch of the actuator **58** in the open or off position such that the fastener **19** exits the belt **24** into the first collector **62** in the failed position. From either block **222** or block **224**, the methodology advances to block **226** to be described.

[0052] In block **226**, the methodology denies the inspection criteria. The camera controller **70** compares the digital image to data stored in memory to validate the inspection criteria. If the inspection criteria is not valid, the camera controller **70** sends a signal to the apparatus controller **84** and rejects the inspected object. The methodology also ignores pass signals for a given distance of travel of the belt **24**. The camera controller **70** sends a signal to the apparatus controller **84** to ignore pass signals for fasteners **19** for a given distance of travel of the belt **24**. The controller opens the switch and maintains the solenoid valve of the actuator **58** in an open or off position. The methodology then ends. It should be appreciated that the default mode is the failed position.

[0053] Accordingly, the present invention is an inspection methodology and apparatus **10** that is designed to inspect a flow of objects or parts in an ordinate and incremental position at a high rate of speed.

[0054] The present invention has been described in an illustrative manner. It is to be understood that the terminology, which has been used, is intended to be in the nature of words of description rather than of limitation.

[0055] Many modifications and variations of the present invention are possible in light of the above teachings. Therefore, within the scope of the appended claims, the present invention may be practiced other than as specifically described.

What is claimed is:

1. A method for inspecting objects for an inspection criteria thereon, said method comprising the steps of:

providing a conveyor;

receiving a plurality of objects on the conveyor and conveying the objects along the conveyor;

inspecting the objects with an inspection system located along the conveyor against a predetermined inspection criteria;

determining to reject or pass the inspected objects; and

removing the passed objects from the conveyor with a removal assembly by actuating the removal assembly if the inspected objects are passed, and leaving the rejected objects on the conveyor if the inspected objects are rejected to subsequently exit the conveyor.

2. A method as set forth in claim **1** including the step of disposing a collector system along the conveyor after the inspection system for collecting the passed and failed objects.

3. A method as set forth in claim **2** including the step of providing the collector system with a first collector for objects that have failed inspection and a second collector for objects that have passed inspection.

4. A method as set forth in claim **3** including the step of providing a purge tube and an actuator for the removal assembly.

5. A method as set forth in claim **4** including the step of actuating the actuator and allowing air from a source to the purge tube to remove the object from the conveyor in response to a passed condition.

6. A method as set forth in claim **1** including the step of providing at least one camera, at least one light source, and a camera controller for the inspection system.

7. A method as set forth in claim **6** including the step of comparing the inspected objects against a predetermined inspection criteria using the camera controller and determining whether to reject or pass the inspected object.

8. A method as set forth in claim **1** including the step of providing a belt and at least one magnetic assembly disposed below the belt for the conveyor.

9. A method of inspecting fasteners for an inspection criteria thereon, said method comprising the steps of:

providing a conveyor;

receiving a plurality of fasteners on the conveyor and conveying the fasteners along the conveyor;

sensing a presence of each of the fasteners along the conveyor with a sensor and triggering at least one inspection camera;

determining whether inspection criteria inspected by the inspection camera on each of the fasteners is acceptable;

validating the inspection criteria if the inspection criteria of each of the fasteners inspected is acceptable and sending a signal to an actuator located along the conveyor;

denying the inspection criteria if the inspection criteria of each of the fasteners inspected is not acceptable;

automatically denying each of the defective fasteners;

validating inspection criteria if the inspection criteria is acceptable and sending a signal to an actuator of a removal assembly; and

activating the actuator to remove the validated fasteners from the conveyor.

10. A method as set forth in claim **9** including the step of tracking each of the fasteners along the conveyor.

11. A method as set forth in claim **10** including the step of sensing a presence of each of the fasteners with a sensor and triggering at least one secondary camera.

12. A method as set forth in claim **11** including the step of continuing to track each of the fasteners and denying inspection criteria if the inspection criteria is not acceptable.

13. A method as set forth in claim **12** including the step of ignoring pass signals for a given distance of travel of the conveyor.

14. A method as set forth in claim **9** including the step of selecting a customer part number.

15. A method as set forth in claim **14** including the step of recognizing the selected customer part number and operating the cameras according to customer inspection criteria.

16. A method as set forth in claim **14** including the step of inputting a new customer part number and configuring the cameras to a customer inspection criteria.

17. A method for coating and inspecting objects, said method comprising the steps of:

providing a conveyor;

receiving a plurality of objects on the conveyor and conveying the objects along the conveyor;

applying a coating material to a portion of the objects with at least one applicator located along the conveyor;

inspecting the objects with an inspection system located along the conveyor against a predetermined inspection criteria;

determining whether to reject or pass the inspected objects; and

removing the passed objects from the conveyor with a removal assembly by actuating the removal assembly if the inspected objects are passed, and leaving the rejected objects on the conveyor if the inspected objects are rejected to subsequently exit the conveyor.

18. A method as set forth in claim **17** including the step of heating the objects to an elevated temperature prior to said step of applying.

19. A method as set forth in claim **18** wherein said step of applying comprise providing a liquid applicator system along the conveyor and applying a liquid coating to the heated objects.

20. A method as set forth in claim **19** including the step of providing an actuator and purge tube for the removal assembly between a first collector and a second collector.

21. A method as set forth in claim **20** including the step of actuating the actuator and allowing air to the purge tube to remove inspected objects that have passed inspection to the second collector and allowing inspected objects that have failed inspection to remain on the conveyor and exit the conveyor in the first collector.

22. A method as set forth in claim **17** wherein said step of inspecting includes providing at least one camera, a light source, and a camera controller communicating with the at least one camera.

23. A method as set forth in claim **22** wherein said step of inspecting includes comparing the inspected objects against a predetermined inspection criteria with the camera controller and determining whether to reject or pass the inspected objects.

24. A method as set forth in claim **17** including the step of providing a belt and at least one magnet disposed below the belt for the conveyor.

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